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EFFECT OF FLYASH AND VERMICOMPOST ON NUTRIENT STATUS OF PLANT AND SOIL OF LEMONGRASS (*CYMBOPOGON FLEXUOSUS* NEES)

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ABSTRACT

The present investigation was undertaken to study the effect of different levels of fly ash and vermicompost on the nutrient status of plant and soil of lemongrass (Cymbopogon flexuosus Nees.) during the year 2014-2015 at Central Institute of Medicinal and Aromatic Plants (CIMAP), Boduppal, Hyderabad. The experiment was carried out in Randomized Block Design with three replications. The data were recorded on NPK of soil (Kg/ha) and NPK of plant (%) for two crops. From the study, the results enunciated that soil NPK values recorded highest in T_1. N has gradually decreased from T_1 to T_{11} while K has increased from T_1 to T_{11}. Highest plant N (2.46 % and 2.07 %), P (0.38% and 0.33 %) and K (3.4 % and 3.52 %) were recorded at 90 and 180 days, respectively in T_7. The treatment T_7 remained on par with T_6, T_8, T_9, T_{10} and T_{11} treatments for NPK of plant. Hence, treatment T_7 (FA 6 t/ha + VC 4 t/ha) can be recommended as the best treatment for increasing plant nutrient status, which leads to better growth of the lemongrass at the same time protecting the soil health on a long term basis.

KEYWORDS: Fly Ash & Vermicompost

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Original Article

INTRODUCTION

Lemongrass (*Cymbopogon flexuosus* Nees) is a perennial multi cut aromatic grass belonging to the family Poaceae. Its oil is in great demand in the country and is also exported in large quantity. Lemongrass is grown in the states of Kerala, Karnataka, U.P and Assam. The oil is a good source of control and is used in perfumery industry, cosmetics, synthesis of Vitamin A, flavouring herbal teas and other non-alcoholic beverages, confectioneries, scenting of soaps, detergents and insect repellent preparations. The oil also has germicidal, medicinal and flavouring properties.

Lemongrass is known to be a very hardy plant that can grow in soil types ranging from rich loam to poor laterite, but with a preference to well drained and nutrient rich soils. The plant is also known for its tolerance to soil salinity and alkalinity to a higher level than other crops. The annual world production of lemongrass oil is around 1000 tonnes. In some far Eastern countries like Java, Japan, China and India the leaves are used for flavoring foods, drinks and tea and for scenting bathwater.

Lemon grass is generally recognized as safe for human consumption as plant extract/essential oil. In the case of aromatic plants such as lemon grass, the quality and the quantity of essential oil are important aspects. Organic farming is gaining momentum, especially in the cultivation of medicinal and aromatic plants owing to reputed improvements in the quality of the produce under organic systems of farming as well as the price premiums for certified produce. Fly ash is a by-product of pulverized coal fired thermal power stations. Fly ash

contains several essential nutrients like K, P, CA, Mg, S, B, Fe, Cu, Zn, Mn and Mo, which are beneficial for plant growth. Fly ash improves the fertility status of soil, structure, texture and physical properties and improves crop yield. It optimizes pH value, improves soil aeration and reduces crusting formation. The research done so far in agricultural and horticultural crops indicates that the fly ash could be a better option to replace the chemical fertilizers in developing countries. The best alternative of the present day's environmental degradation is to make proper use of the available unutilized organic biodegradable wastes in order to convert them into compost within a short period.

Vermicompost is found to effectively enhance the root formation, elongation of stems and production of biomass in agricultural and horticultural plants. Vermicompost has higher levels of available nutrients like nitrate or ammonium nitrogen, exchangeable phosphorous and soluble potassium, calcium derived from the wastes. Vermicompost stimulates the growth of a wide range of plant species of different horticultural crops due to several direct and indirect beneficial effects as in pepper Arancon *et al*., (2005). Vermicompost has also been found to have positive effects for some aromatic and medicinal plants Anwar *et al*., (2005). It exerts a positive effect on vegetative growth, stimulating shoot and root development Edwards *et al*., (2004). Hence, the experiment was conducted with the object to find out the combine effect of fly ash and verimicompost on the nutrient status of lemongrass.

MATERIAL AND METHODS

The variety selected for the present experiment was Krishna, which was released by CIMAP, Lucknow for cultivation in South India. The experiment was laid out in Randomized Block Design with twelve treatments replicated thrice. Gross plot size: 3.9 × 3.9 m and net plot size of: 3.6×3.6 m. A spacing of 60 cm between the rows and 60 cm between the plants and within the rows was adopted for all the treatments.

The treatments included T_1 : (F_0 + V_{10}) Fly ash(0 t/ha) + Vermicompost (10 t/ha), T_2 : (F_1 + V_9) Fly ash (1 t/ha) + Vermicompost (9 t/ha), T_3 (F_2 + V_8) : Fly ash (2 t/ha) + Vermicompost (8 t/ha), T_4:(F_3 + V_7) Fly ash (3 t/ha) + Vermicompost (7 t/ha), T_5 : (F_4 + V_6) Fly ash (4 t/ha) + Vermicompost (6 t/ha), T_6 : (F_5 + V_5) Fly ash (5 t/ha) + Vermicompost (5 t/ha), T_7 :(F_6 + V_4) Fly ash (6 t/ha) + Vermicompost (4 t/ha), T_8: (F_7 + V_3) Fly ash (7 t/ha) + Vermicompost (3 t/ha), T_9 : (F_8 + V_2) Fly ash (8 t/ha) + Vermicompost (2 t/ha), T_{10} : (F_9 + V_1) Fly ash (9 t/ha) + Vermicompost (1 t/ha), T_{11} : (F_{10} + V_0) Fly ash (10 t/ha) + Vermicompost (0 t/ha), T_{12} : Normal dose of chemical fertilizer (100:40:40 kg/ha), T_{13} : Zero fertilizer (control).

Treatments were imposed on the standing crop after first harvest. The experimental area was kept weed free. Weeding was done at 30 days interval. The first irrigation was given immediately after planting. The subsequent irrigations were given as and when required, depending upon soil moisture and weather conditions. Twenty five irrigations were given to the crop in 6 months duration. Lemongrass is a multi harvest perennial crop. The first harvest of the crop is taken 90 days and second harvest was taken at 180 days.

Estimation Methodology of NPK of Soil (Kg/Ha)

The collected soil samples were processed (dried, ground and sieved) before they were analyzed, and before treatment imposition and after each harvest.

Estimation of Nitrogen

Available N was estimated by an alkaline permanganate method. Five grams of soil sample were distilled using

kjelplus and the liberated ammonia is condensed and collected in boric acid, and is titrated against standard H_2SO_4. The available N in soil was expressed in kg/ha.

Estimation of Phosphorous

The available P is extracted using Olsen's extraction, which is added to two grams of soil. To the extract a drop of p-nitrophenol and reagent B (reagent A [12 g/200 ml of ammonium molybdate + 0.2908 g/100 ml of antimony potassium tartrate + 1000 ml of 2.5 M H_2SO_4 and made up to 2 liters] + 1.056 g/100 ml ascorbic acid) were added. According to the intensity of the colour of the contents, the absorbance value was recorded using a spectrophotometer and incorporated into the standard graph, which gave the concentration of P. The available P in soil was expressed in kg/ha.

Estimation of Potassium

The available soil K is estimated by flame photometry. The neutral normal ammonium acetate, which extracts water soluble and exchangeable K was used for the determination of available K in soil. The available K in soil was expressed in kg/ha

Estimation Methodology of NPK of Plant (%)

The plant samples were collected and analyzed after each harvest at CIMAP laboratory, Boduppal, Hyderabad.

Preparation of Plant Samples

Fully matured index leaf was collected from each treatment. The collected leaf samples were decontaminated by washing thoroughly with ordinary water, 0.2% detergent (Teepol, laboratory grade), 0.1N HCl, distilled water and finally by double distilled water. These samples were dried in oven at 60ºC till constant weight was obtained. The dried leaves were pounded by using a pestle and mortar. The procedures adopted for the analysis of nutrients are briefly outlined below. A half gram of oven dried and powdered leaf sample was taken in 50 ml conical flasks for digestion using diced (9:4; Nitric acid: Perchloric acid). 10 ml of the diced mixture was added and was allowed overnight for pre-digested and then heated at 100° c for an hour and 250°c until colorless clear solution obtained. It was cool and the volume was made up to 100 ml with distilled water. The same was used for estimation of P and K. For nitrogen estimation, 0.5 g plant sample was digested using a 2 g digestion mixture consisting of copper sulfate, potassium sulfate in 5:1 ratio and 10 ml of sulfuric acid on the digestion unit at 450ºC till the light green color appears.

Estimation of Nitrogen

Nitrogen was determined by Kjeldhal's method. Half gram digested plant sample was distilled using micro-Kjeldhal unit and the liberated ammonia were trapped in boric acid containing mixed indicator and titrated against 0.01 N H_2SO_4 (Jackson, 1973). The nitrogen content in the leaves was expressed in percent.

Estimation of Phosphorus

Diacid digested plant sample was used for the determination of total phosphorus by developing vanadomolybdo phosphoric yellow color following the method of Jackson (1973). The intensity of yellow color was read in spectrometer (Systronics UV-VIS Spectrophotometer 118) at 470 NM. The phosphorus content in the leaves was expressed in percent.

Estimation of Potassium

Potassium content was determined by a microprocessor based flame photometer using specific filter and LPG

flame. Diluted decide digest was fed to atomize through capillary tube, and concentration was directly read on the display monitor. Per cent potassium content on dry weight basis was calculated (Chapman and Pratt, 1961). The potassium content in the leaves was expressed in percent.

RESULTS AND DISCUSSIONS

Effect of Different Doses of Fly Ash and Vermicompost on NPK Content of Soil (kg/ha)

The data pertaining to nitrogen, phosphorous and potassium content in soil at each harvest of the crop are presented in Table 1. NPK status of soil increased after the application of fly ash and vermicompost. At the end of the first crop and second crop, significant differences for N, P and K of soil were observed due to different levels of fly ash and vermicompost. For both the harvests among the different treatments of fly ash and vermicompost, the treatment T_{12} (Recommended dose fertilizer) has recorded significant maximum soil nitrogen, phosphorous and the treatment T_{11} recorded maximum potassium content at harvest of the first and second crop. The nitrogen content was decreased from T_1 to T_{11} while the potassium content was increased from T_1 to $T_{11.}$ $_M$inimum soil nitrogen, phosphorous and potassium content was recorded by the treatment T_{13} (Zero fertilizer).

The observations from the table reveal that the NPK of soil were maximum for the treatment T_{12} that received recommended dose of fertilizer. It might be due to the factor of readily available form of N, P and K. Nitrogen decreased from T_1 to T_{11} due to a decreased dose of vermicompost as the vermicompost was the major source of nitrogen. Potassium increased from T1 to T11 and recorded maximum for the treatment T11 as the fly ash was a major source of potassium.

The results are in accordance with the findings of Neelima *et al*. (1995) where, high yield of aromatic grasses, particularly Palmarosa and citronella is attributed to the increased availability of major plant nutrients in the presence of different fly ash-soil combinations. Fly ash application improved the availability of P and K. Srivastava and Chhonkar, (2000). The graded level of coal fly ash amended soils revealed an increase in the content of N, P and K. Jaywanti *et al*., (2011). Agricultural soil, when amended with fly ash provided macronutrients (Gupta and Tarar, (2012) to the plant).

Table 1: Effect of Fly Ash and Vermicompost on Available NPK of Soil (kg/ha)

	Treatments	90 Days After Planting			180 Days After Planting		
		N	P_2O_5	K_2O	N	P_2O_5	K_2O
T_1	Fly ash (0t/ha) + Vermicompost (10t/ha)	434.9	24.5	181.3	391.9	19.6	155.1
T_2	Fly ash (1t/ha) + Vermicompost (9t/ha)	428.5	23.2	210.4	385.1	18.4	193.8
T_3	Fly ash (2t/ha) + Vermicompost (8t/ha)	421.6	15.6	252.6	379.1	15.7	222.6
T_4	Fly ash (3t/ha) + Vermicompost (7t/ha)	405.5	22.6	265.9	363.6	17.9	232.1
T_5	Fly ash (4t/ha) + Vermicompost (6t/ha)	384.3	19.4	310.4	346.8	18.7	282.3
T_6	Fly ash (5t/ha) + Vermicompost (5t/ha)	382.4	17.8	340.1	342.9	14.8	192.3
T_7	Fly ash (6t/ha) + Vermicompost (4t/ha)	380.4	20.8	374.9	341.7	18.9	352.7
T_8	Fly ash (7t/ha) + Vermicompost (3t/ha)	378.5	18.1	401.2	336.1	16.7	391.7
T_9	Fly ash (8t/ha) + Vermicompost (2t/ha)	374.2	16.6	451.5	332.5	13.7	410.7
T_{10}	Fly ash (9t/ha) + Vermicompost (1t/ha)	361.4	15.3	495.2	328.5	12.3	455.6
T_{11}	Fly ash (10t/ha) + Vermicompost (0t/ha)	358.5	17.8	531	322.7	14.1	512.1
T_{12}	Recommended dose of fertilizer	337.6	27.8	386.7	301.7	23.7	353.2
T_{13}	Zero fertilizer (control)	286.4	8.3	163.1	272.4	6.9	136
	SEm±	5.357	1.801	10.595	3.111	0.451	25.35
	CD (0.05)	15.730	5.287	31.108	9.134	1.325	74.4

Effect of Different Doses of Flyash and Vermicompost on NPK Content of Plant (%)

The treatments showed significant differences for plant nitrogen, phosphorous and potassium content due to

different combinations of fly ash and vermicompost, at first and second harvest. For both the harvests, the treatment T_7 (FA 6 t/ha + VC 4 t/ha) has recorded significant maximum plant nitrogen, phosphorous and potassium contents. The treatment T_7 was on par with T_6 (FA 5 t/ha + VC 5 t/ha), T_8 (FA 7 t/ha + VC 3 t/ha), T_9 (FA 8 t/ha + VC 2 t/ha), T_{10} (FA 9 t/ha + VC 1 t/ha) and T_{11} (FA 10 t/ha + VC 0 t/ha). The observations from the table reveal that the plant N, P and K were maximum in T_7 with 6 t/ha of fly ash and 4 t/ha of vermicompost. Further increase of fly ash from 8 to 10 t/ha for the treatments plant NPK did not differ significantly.

Maximum plant N, P and K as recorded with the treatment T_7 (FA 6 t/ha + VC 4 t/ha) might be due to the combined application of nutrient rich fly ash and vermicompost to the soil, that increased the availability of nutrients. The uptake of NPK was triggered by the micronutrients, which are present in fly ash and resulted in maximum plant NPK content. Though the level of vermicompost increased for the treatments T_5 (FA 4 t/ha + VC 6 t/ha) to T_1 (FA 0 t/ha + VC 10 t/ha), there was no significant improvement in NPK content. This may be due to the lower doses of fly ash.

Kuchanwar *et al.* (1997) observed similar results in a ground nut. The application of fly ash (10 t/ha) increased the uptake of N, P and K in the plant. Highest content and uptake of nutrients were recorded in green gram with increasing levels of fly ash up to 10 t /ha Bhaisare *et al*., (2000). Total mean nutrient uptake in rice has increased under integrated plant nutrient supply, including fly ash Selvakumari *et al*., (2000). P and K content of sodden grass and oats increased with graded levels of fly ash incorporation in soil up to 100 g/Kg. Uptake of N, P and K both in grain and straw of pearl millet and wheat crops was found higher in fly ash treated plots over control Grewal *et al*., (2001). Significantly, highest content and uptake of N, P and K in seed and straw of sunflower was recorded due to 60 t/ha of fly ash application. Bhoyar *et al*., (2007).

Significantly, higher uptake of NPK was observed due to the application of fly ash in combination with organic materials and chemical fertilizers (Basu *et al*., (2010a). The uptake of macro nutrients by coupe, due to the combined application of biosolids and fly ash was reported by Yeledhalli *et al.* (2008).

Further, the higher uptake of NPK by grain and stover of pearl millet due to application of 1.5 t/ha vermicompost was reported by Jadhav *et al*., (2011). Vermicompost application improved NPK content in anise. Khalesro *et al*., (2012). Vermicompost improved nutritional status of cauliflower at a statistically significant level. Tavali *et al*., (2013). The highest value of P and K concentrations in the muskmelon seedlings was reported by Man and Wang (2014) by using substrate with a mixture of vermicompost, rice hulls and coconut husk (1:1:1). The application of vermicompost up to 4 t/ha significantly increased total uptake of N, P and K. Verma *et al*., (2014).

However, it was found that the treatments T_6 (FA 5 t/ha + VC 5 t/ha), T_8 (FA 7 t/ha + VC 3 t/ha), T_9 (FA 8 t/ha + VC 2 t/ha), T_{10} (FA 9 t/ha + VC 1 t/ha) and T_{11} (FA 10 t/ha + VC 0 t/ha) were also on par with T_7 (FA 6 t/ha + VC 4 t/ha). When T_7 (FA 6 t/ha + VC 4 t/ha) is compared with T_{11} (FA 10 t/ha + VC 0 t/ha). T_{11} (FA 10 t/ha + VC 0 t/ha) is cost effective as it has no vermicompost but fly ash alone at higher levels may affect soil health in a short period of 2-3 years. Likewise, in T_{11} (FA 10 t/ha + VC 0 t/ha), 10 t/ha fly ash was applied; where absolutely no nitrogen is available from fly ash in soil and plant. In view of increasing the nutrient status of soil and plant, it is always considered as best to combine fly ash at lower levels with vermicompost or any other organic source of nutrients that has nitrogen, so that the combination will supply balanced nutrients to the soil and plant and hence compared to T_{11} (FA 10 t/ha + VC 0 t/ha), T_7 (FA 6 t/ha + VC 4 t/ha) is recommended in case of lemongrass, which is a perennial crop cultivated for 4-5 years.

Table 2: Effect of Fly Ash and Vermicompost on NPK (%) of Plant

	Treatments	90 Days after Planting			180 days after Planting		
		N	P_2O_5	K_2O	N	P_2O_5	K_2O
T_1	Fly ash (0t/ha) + Vermicompost (10t/ha)	1.68	0.18	2.21	1.33	0.16	2.29
T_2	Fly ash (1t/ha) + Vermicompost (9t/ha)	1.79	0.18	2.45	1.42	0.15	2.55
T_3	Fly ash (2t/ha) + Vermicompost (8t/ha)	1.86	0.19	2.16	1.52	0.16	1.93
T_4	Fly ash (3t/ha) + Vermicompost (7t/ha)	2.02	0.23	2.35	1.73	0.19	2.32
T_5	Fly ash (4t/ha) + Vermicompost (6t/ha)	2.19	0.22	2.53	1.86	0.18	2.29
T_6	Fly ash (5t/ha) + Vermicompost (5t/ha)	2.23	0.28	2.73	1.93	0.21	2.45
T_7	Fly ash (6t/ha) + Vermicompost (4t/ha)	2.46	0.38	3.4	2.07	0.33	3.52
T_8	Fly ash (7t/ha) + Vermicompost (3t/ha)	2.18	0.34	2.9	1.79	0.26	2.49
T_9	Fly ash (8t/ha) + Vermicompost (2t/ha)	2.09	0.31	2.95	1.62	0.27	2.63
T_{10}	Fly ash (9t/ha) + Vermicompost (1t/ha)	2.31	0.33	2.66	1.92	0.26	2.31
T_{11}	Fly ash (10t/ha) + Vermicompost (0t/ha)	2.19	0.26	2.8	1.82	0.18	2.91
T_{12}	Recommended dose of fertilizer	1.92	0.39	2.23	1.67	0.33	2.31
T_{13}	Zero fertilizer (control)	0.98	0.26	1.62	0.69	0.9	1.56
	SEm±	0.029	0.040	0.097	0.096	0.026	0.180
	CD (0.05)	0.086	0.116	0.285	0.283	0.077	0.530

CONCLUSIONS

Keeping in view the importance of organically produced oil of lemongrass, and the premium price it is being offered in the international trade, cultivation of lemongrass with cheap organic sources like fly ash is beneficial to the farmer to compensate the cost of inputs. In this regard also, T_7 (FA 6 t/ha + VC 4 t/ha) can be recommended, where the cost of inputs can be compensated with high herb yield and in turn essential oil yield.

Hence, in view of protecting soil health on a long term basis, T_7 (FA 6 t/ha + VC 4 t/ha) with lower doses of fly ash, which gradually improves soil physico-chemical properties are found to be the best treatment for a perennial aromatic crop like lemongrass. Hence, treatment T_7 (FA 6 t/ha + VC 4 t/ha) can be recommended as the best treatment for increasing plant nutrient status, which leads to better growth of the lemongrass, at the same time, protecting the soil health on a long term basis. So, this investigation strongly suggests that fly ash can be used as an effective organic source in combination with other organic sources of nutrients in the cultivation of aromatic crops specially lemongrass.

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